# PROPERTIES OF MATTER

# 7

## KIPS MULTIPLE CHOICE QUESTIONS

1. **The property of the matter due to which it restores its size and shape when force ceases to act on it:**
a) Inertia b) Elasticity c) Permittivity d) Rigidity

2. **The force that acts on unit area of an object and thus changes its shape or size:**
a) Stress b) Strain c) Yong's Modulus d) Elastic limit

3. **In system international, the unit of stress is:**
a) $Nm^{-2}$ b) $Nm^{-1}$ c) Nm d) None of above

4. **The ratio of change in length to the original length is:**
a) Stress b) Strain c) Yong's Modulus d) Elastic limit

5. **When stress is increased, the strain also goes on:**
a) Decreasing b) Increasing c) Constant d) All of above

6. **The law about stress and strain is presented by:**
a) Hook b) Newton c) Joule d) Archimedes

7. **According to Hooke's law, within the elastic limit stress and strain has -------------- proportion:**
a) Inverse b) Direct c) Same d) None of above

8. **The ratio of tensile stress and tensile strain is:**
a) Variable b) Constant c) Uniform d) None of above

9. **The unit of Young's modulus is:**
a) $Nm^{-2}$ b) $Nm^{-1}$ c) Nm d) None of above

10. **The force exerted perpendicularly on unit area of an object is called:**
a) Strain b) Constant c) Pressure d) Work

11. **The unit of pressure is:**
a) $Nm^{-2}$ b) $Nm^{-1}$ c) Pa d) Both a & c

12. **Pressure depends upon:**
a) Density b) Depth c) Temperature d) Both a & b

13. **If a body is at a depth of 'h' from the liquid surface of density 'ρ', then the pressure 'P' on that body is:**
a) $P = w/t$ b) $P = \rho gV$ c) $P = \rho gh$ d) $P = F/a$

14. **The law about pressure on the object is presented by:**
a) Joule b) Pascal c) Newton d) Galileo

15. **Hydraulic press is based on:**
a) Joule's law b) Pascal law c) Newton's law d) Young's Modulus

16. **If pressure is exerted on a liquid, liquid transmits it:**
a) Variably b) Equally c) In all directions d) both b & c

17. **Hydraulic brake works on the principle of:**
a) Hydraulic press b) Pascal law c) Joule's law d) Both a & b

18. **------------------ tells about the floating and sinking of objects:**
a) Pascal's law b) Newton's law c) Archimedes principle d) None of them

19. **Due to pressure difference on an object, an upward force acts on the object known as:**
a) Weight b) Buoyant force c) Stress d) All of above

20. **Buoyant force is equal to the ---------- of the liquid displaced by the object:**
a) Volume b) Density c) Weight d) All of above

21. **The object will float on the liquid surface when:**
a) $W > F$ b) $W < F$ c) $W = F$ d) None of above

22. **The object will sink in the liquid surface when:**
a) $W > F$ b) $W < F$ c) $W = F$ d) None of above

23. **Submarine works on the principle of:**
a) Pascal's law b) Newton's law c) Archimedes principle d) None of them

24. **When temperature of the gas increases, gas pressure --------------:**
a) Increases b) Decreases c) Remains same d) None of above

25. **If quantity of the gas is increased in the container then gas pressure -------:**
a) Increases b) Decreases c) Remains same d) None of above

26. **According to Kinetic Molecular theory, gases exert pressure on the walls of the container due to their:**
a) Weight b) Mass c) Collisions d) All of above

27. **The molecules of the matter are always remain in the state of:**
a) Rest b) Plasma c) Motion d) Tension

28. **The energy possessed by the molecules of the matter is due to its motion:**
a) P.E. b) K.E. c) Sound d) None of above

29. **When temperature of the matter increases, intermolecular forces ------:**
a) Increases b) Decreases c) Remains same d) None of above

30. **Molecules of which state of matter have strongest attractive for**
a) Solid b) Liquid c) Gasses d) Plasma

31. **How many states of mother are?**
a) 2 b) 3 c) 4 d) many

32. **Weakest attractive forces are in**
a) solid b) liquid c) gases d) Plasma

33. **Weakest attractive forces are in**
a) solid b) liquid c) gases d) plasma

**34. Ionic state of matter is called**

a) gas　b) plasma　c) liquid　d) none of these

**35. Plasma is**

a) Good conductor　b) Bad conductor　c) Semi conductor　d) non conductor

**36. Unit of density**

a) kg $m^3$　b) kg $m^{-2}$　c) kg $m^{-3}$　d) kg $m^2$

**37. Unit of pressure is**

a) $Nm^{-2}$　b) Pa　c) Nm　d) Both a & b

**38. The instrument used to measure atmospheric pressure**

a) Colorimeter　b) Hypsometer　c) Barometer　d) None of these

**39. A solid object is:**

a) Not elastic below the elastic limit　b) Elastic above the elastic limit

c) Elastic below the elastic limit　d) None of above

## ANSWER KEY

| Q. | Ans | Q. | Ans | Q. | Ans | Q. | Ans |
|---|---|---|---|---|---|---|---|
| 1 | b | 11 | d | 21 | b | 31 | c |
| 2 | a | 12 | d | 22 | a | 32 | c |
| 3 | a | 13 | c | 23 | c | 33 | b |
| 4 | d | 14 | b | 24 | a | 34 | d |
| 5 | b | 15 | b | 25 | a | 35 | c |
| 6 | a | 16 | d | 26 | d | 36 | c |
| 7 | b | 17 | b | 27 | c | 37 | c |
| 8 | d | 18 | c | 28 | b | 38 | d |
| 9 | a | 19 | b | 29 | b | 39 | c |
| 10 | c | 20 | c | 30 | a | | |

## KIPS SHORT QUESTIONS

**Q.1 What is Kinetic molecular theory? Write down its postulates.**

**Ans:** Most of the properties of solids, liquids, and gases can be explained on the basis of the intermolecular forces. Kinetic molecular model has some important features.

- Matter is made up of particles called molecules.
- The molecules remain in continuous motion. The motion of molecules could be linear, vibrational, or rotational.
- The molecules attract each other.

**Q.2 What is plasma?**

The kinetic energy of gas molecules goes on increasing if a gas is heated continuously. This causes the gas molecules move faster and faster. The collisions between atoms and molecules of the gas become so strong that they tear off the atoms. Atoms lose their electrons and become positive ions. This ionic state of matter is called plasma.

**Q.3 What do you know about density?**

**Ans:** Density of a substance is defined as its mass per unit volume.

$$\text{Density} = \frac{\text{mass of a substance}}{\text{volume of that substance}}$$

**Unit**

SI unit of density is kilogram per cubic meter (kg $m^{-3}$).

**Density Equations**

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Mass = Density x Volume

$$\text{Volume} = \frac{\text{Mass}}{\text{Density}}$$

**Q.4 Define pressure and write down its unit.**

The force acting normally per unit area on the surface of a body is called pressure.

Thus $$P = \frac{\text{Force}}{\text{Area}}$$

Or $$P = \frac{F}{A}$$

**Quantity**

Pressure is a scalar quantity.

**Unit**

In SI units, the unit of pressure is N $m^{-2}$ also called Pascal (Pa). Thus, 1N $m^{-2}$ = 1Pa

**Q.5 Define pressure in liquids.**

**Ans:** Liquids exert pressure. The pressure of a liquid acts in all directions. If we take pressure sensor (a device that measures pressure) inside a liquid, then the pressure of the liquid varies with the depth of sensor.

**Q.6 State Pascal's Law.**

**Ans:** Pressure applied at any point of a liquid enclosed in a container; is transmitted without the loss to all other parts of the liquid.

An external force applied on the surface of a liquid increases the liquid pressure at the surface of the liquid. This increase in liquid pressure is transmitted equally in all direction and to the walls of the container in which it is filled.

**Q.7 Explain the braking system of the vehicles.**

**Ans:** The brakes of cars, buses etc. work on the principle of Pascal's law. In such a type of brakes, when brake pedal is pushed, it exerts pressure on the master cylinder, which increases the liquid pressure in the cylinder. The liquid pressure is transmitted equally through the liquid in the metal pipes. Due to the increase pressure of the liquid pressure, the pistons in the cylinder mover outwards pressing the brakes pad with brake drums. The force of friction between friction the brake pads and the brake drum stops the wheels.

**Q.8 State Archimedes Principle.**

**Ans:** When object is totally or partially immersed in a liquid, an upthrust act on it equal to the weight of the liquid it displaces.

**Q.9 Define principle of floatation**

A floating object displaces a fluid having weight equal to weight of the object.

**Q.10 What is atmospheric pressure?**

The earth is surrounded by a cover of air is called atmosphere. It extends to a few hundred kilometers above sea level. Just as certain sea creatures live at the bottom of ocean, we live at the bottom of a huge ocean of air. Air is the mixture of gases. The density of air in the atmosphere is not uniform. It decreases continuously as we go up.

**Q.11 What is barometer?**

The instruments that measure atmospheric pressure are called barometers. One of the simple barometers is a mercury barometer. It consists of a glass tube 1 m long closed at one end.

**Q.12 Why mercury is used in barometer instead of water?**

Mercury is 13.6 times denser than water. Atmospheric pressure can hold vertical column of water is about 13.6 times the height of mercury column at a place. Thus, at sea level, vertical height of water column would be $0.76\ m \times 13.6 = 10.34\ m$. Thus, a glass tube more than 11 m long is required to make a water barometer.

**Q.13 What weather changes can be expected due to decrease of atmospheric pressure?**

- A gradual and average drop in atmospheric pressure means a low pressure in a neighboring locality.
- Minor but rapid fall in atmosphere indicates a windy and showery condition in the nearby region.
- A decrease in atmospheric pressure accompanied by breeze and rain.
- A sudden fall in atmospheric pressure often followed by a storm, rain and typhoon to occur in few hours time.

**Q.14 What weather changes can be expected due to increase of atmospheric pressure?**

- An increasing atmospheric pressure with a decline later on predicts an intense weather conditions.
- A gradual large increase in the atmospheric pressure indicates a long spell of pleasant weather.
- A rapid increase in atmospheric pressure means that it will soon be followed by a decrease in the atmospheric pressure indicating poor weather ahead.

**Q.15 What is Elasticity?**

**Ans:** The property of a body to restore its original size and shape as the deforming force ceases to act is called elasticity.

**Deforming force**

The applied force that changes shape, length or volume of a substance is called the deforming force.

**Q.16 What is stress?**

**Ans:** The force that acts on unit area at the surface of a body and thus changes its shape or size is called stress.

**Mathematical form**

If a force F is applied on an area A of an object, the stress is) mathematically defined as:

$$\text{Stress} = \frac{F}{A}$$

**Unit**

In System International, the unit of stress is $Nm^{-2}$.

**Q.17 What is strain?**

**Ans:** A stress can produce a change in shape, length or volume of an object.

A comparison of change caused by the stress with the original length, volume or shape is called the strain.

**Tensile strain**

If a stress produces a change in length of an object then the stain is called tensile strain.

Therefore,

$$\text{Tensile Strain} = \frac{\text{Change in Length}}{\text{Original Length}}$$

**Unit**

As the strain is a ratio between tw[illegible]nilar quantities so it has no unit.

**Q.18 Hooke's Law**

**Ans:** The strain produced in a body by the stress applied to it is directly proportional to the stress within the elastic limit of the body.

**Mathematical Formula**

Stress α strain

Stress = constant x strain

Or $\frac{\text{Stress}}{\text{Strain}}$ = constant

Hooke's law is applicable to all kinds of deformation and all types of matter i.e. solids, liquids or gases within certain limit.

**Q.19 Define Young's Modulus.**

**Ans:** The ration of stress and strain is a constant within the elastic limit, this constant is called the Young's Modulus.

**Unit**

SI unit of Young's Modulus is Newton per square meter ($N\ m^{-2}$)

**Q.20 What is elastic Limit?**

**Ans:** When stress is increased, the strain also goes on increasing until there comes a limit. When stress is removed, the object does not come back to its initial state. This limit of stress is called elastic limit.

**Q.16 What are the elastic materials? Give some examples.**

**Ans:** An object is said to be elastic if it restores its original size and shape after the external force ceases to act. For example rubber, plastic, nylon, iron etc.

**Q.17 How property of elasticity is used in our body?**

**Ans:** Not only metals and other materials are elastic, our body muscles are also elastic. Most of the actions of our body are possible due to expansion and contraction of the muscles.

**Q.18 Prove that the SI unit of Young's modulus is Pascal or $Nm^{-2}$.**

**Ans:** Pressure is calculated mathematically as:

$$P = \frac{F}{A}$$

$$P = \frac{N}{m^2} = Nm^{-2}$$

Thus, SI unit of pressure is $Nm^{-2}$ and it is also named as Pascal (pa).

**Q.19 Prove that liquid pressure does not depend upon mass of the liquids.**

**Ans:** Liquid pressure is given by the formula:

$$P = \rho g h$$

Above equation is independent of mass of the liquid. So, liquid pressure does not depend upon the mass of the body.

**Q.20 Under what condition the object floats in water?**

**Ans:** If the buoyant force 'F' is greater than the 'w' of the immersed object, the resultant force (F – w) will act in the upward direction and it will push the object in upward direction. In this situation, some part of the object will be raised above the water so that the buoyant force 'F' becomes equal to the weight. So, equilibrium is established and the object floats.

**Q.21 Prove that**

$$P = \rho gh$$

**Ans:**

As we know that $\quad \text{pressure} = P = \dfrac{\text{Force}}{\text{Area}} = \dfrac{F}{A}$

As $F = w$ so $\quad \text{pressure} = P = \dfrac{w}{A}$

As $w = mg$ so $\quad \text{pressure} = P = \dfrac{mg}{A}$

As $m = v \times \rho$ so $\quad \text{pressure} = P = \dfrac{v \times \rho \times g}{A}$

As $v = A \times h$ so $\quad \text{pressure} = P = \dfrac{A \times h \times \rho \times g}{A}$

Therefore $\quad \text{pressure} = P = \rho gh$ as required.

**Q.22 Write any three applications of the Pascal's law in our daily life.**

i. Raw cotton and clothes are pressed to form their bundles for their easy transportation.
ii. For the service of heavy vehicles, these are lifted by the use of hydraulic press.
iii. The brakes of certain vehicles work on the principle of hydraulic press.

**Q.23 When an inflated balloon is heated it bursts. Why?**

**Ans:** When inflated balloon is heated then motion of the molecules of the gas increases in the balloon and they will increase pressure on the walls of the balloon so it will burst because of this increased gas pressure on it.

**Q.24 Under what condition the object sinks in water?**

**Ans:** If the weight 'w' of the immersed object is greater than the buoyant force 'F' of the liquid, the resultant force (w – F) will act in the downward direction and the object will sink.

# LONG QUESTIONS

## 7.1 KINETIC MOLECULAR MODEL OF MATTER

**Q.No.1 Explain different states of matter on the basis of kinetic molecular theory.**

**Ans:** Kinetic molecular model is used to explain the three states of matter – solid, liquid, and gas.

**(i) Solid**

Solids have fixed shapes and volume. Their molecules are held close together. However, they vibrate about their mean positions but do not move from place to place.

Examples are stone, metal spoon, pencil etc.

**(ii) Liquids**

The distance between the molecules of a liquid is more than in solids. Thus, attractive forces between them are weaker. Like solids, molecules of a liquid also vibrate about their mean position but are not rigidly held with each other. Due to the weaker attractive forces, they can slide over one another. Thus, the liquids can flow. The volume of a certain amount of liquid remains the same but because it can flow hence; it attains the shape of a container to which it is put.

**(iii) Gases**

Gases such as air have no fixed shape or volume. They can be filled in any container of any shape. Their molecules have random motion and move with very high velocities. In gases, molecules are much farther apart than solids or liquids. Thus, gases are much lighter than solids and liquids. They can be squeezed into smaller volumes.

**Pressure of gases**

The molecules of a gas are constantly striking the walls of a container. Thus, a gas exerts pressure on the walls of the container.

**(iv) Plasma**

The kinetic energy of gas molecules goes on increasing if a gas is heated continuously. This causes the gas molecules move faster and faster. The collisions between atoms and molecules of the gas become so strong that they tear off the atoms. Atoms lose their electrons and become positive ions. This ionic state of matter is called plasma.

**Plasma in discharge tubes**

Plasma is also formed in gas discharge tubes when electric current passes through these tubes.

**Plasma – The Fourth state of Matter**

Plasma is also called the fourth state of matter in which gas occurs in its ionic state. Positive ions and electrons get separated in the presence of electric and magnetic field. Plasma also exists in neon and fluorescent tubes when they glow.

**Universe formation**

Most of the matters that fill the universe are in plasma state. In stars such as our sun, gases exist in their ionic state.

**Plasma Good Conductor**

Plasma is highly conducting state of mater. It allows electric current to pass through it.

## 7.4 ATMOSPHERIC PRESSURE

**Q.No.2 What is atmospheric pressure? And explain atmospheric pressure with the help of an experiment.**

**Ans:** The earth is surrounded by a cover of air is called atmosphere. It extends to a few hundred kilometers above sea level. Just as certain sea creatures live at the bottom of ocean, we live at the bottom of a huge ocean of air. Air is the mixture of gases. The density of air in the atmosphere is not uniform. It decreases continuously as we go up.

Atmospheric pressure acts in all directions.

**Examples**

Soap bubbles expand till the pressure of air in them is equal to the atmospheric pressure. Soap bubbles so formed have spherical shapes because the atmospheric pressure acts on a bubble equally in all directions.

A balloon expands as we fill air into it. The balloon will expand in all directions.

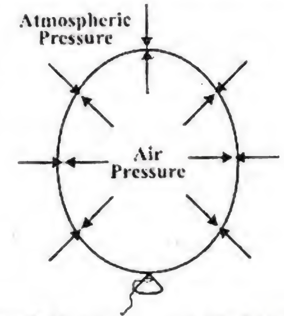

**Figure 7.10:** Air pressure inside the balloon is equal to the atmospheric pressure.

**Experiment**

The fact that atmosphere exerts pressure can be explained by simple experiment. Take an empty tin can with a lid.

Open its cap and put some water in it. Place it over flame. Wait till water begins to boil and the steam expels the air out of the can. Remove it from the flame. Close the can firmly by its cap. Now place the can under tape water. The can will squeeze due to atmospheric pressure.

When the can is cooled by tap water, the steam in it condenses. As the steam changes into water, it leaves an empty space behind it. This lowers the pressure inside the can as compared to the atmospheric pressure outside the can. This will cause that can to collapse from all directions. This experiment shows that atmosphere exerts pressure in all directions.

### *Measuring Atmospheric Pressure*

**Q.No.3 Which device is used to measure the atmospheric pressure? Explain the measurement of atmospheric pressure by using barometer.**

A simple device used to measure the atmospheric pressure is barometer.

**Barometer**

The instruments that measure atmospheric pressure are called barometers. One of the simple barometers is a mercury barometer. It consists of a glass tube 1 m long closed at one end.

**Measurement**

After filling it with mercury, it is inverted in a mercury trough. Mercury in the tube descends and stops at a certain height. The column of mercury held in the tube exerts pressure at its base. At the sea level the height of mercury column above the mercury in the trough is found to be about 76 cm. pressure exerted by 76 cm of air column is nearly 101,300 $Nm^{-2}$ equal to atmospheric pressure.

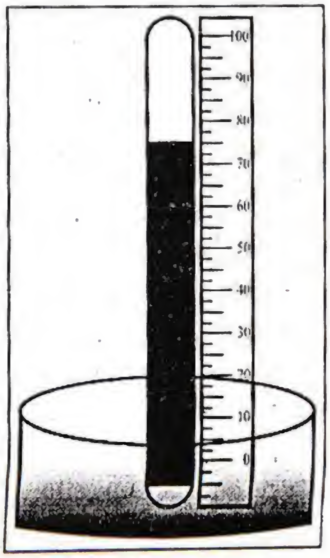

**Figure 7.12:** A mercury barometer

It is common to express atmospheric pressure in terms of the height of mercury column. As the atmospheric pressure at a place does not remains constant, hence, the height of mercury column also varies with atmospheric pressure.

**Atmospheric pressure at sea level**

At sea level, the atmospheric pressure is about 101,300 Pa or 101,300 $Nm^{-2}$.

**Mercury in barometer instead of water**

Mercury is 13.6 times denser than water. Atmospheric pressure can hold vertical column of water is about 13.6 times the height of mercury column at a place. Thus, at sea level, vertical height of water column would be $0.76 \text{ m} \times 13.6 = 10.34 \text{ m}$. Thus, a glass tube more than 10 m long is required to make a water barometer.

## *Variation in Atmospheric Pressure*

**Q.No.4 Write a note on variation in atmospheric pressure.**

**Ans:** The atmospheric pressure decreases as we go up. The atmospheric pressure on mountains is lower that at sea level. At a height of about 30 km, the atmospheric pressure becomes only 7 mm of mercury which is approximately 1000 Pa. it would become zero at an altitude where is no air. Thus we can determine the altitude of a place by knowing the atmospheric pressure at that place.

**Effect of weather on atmospheric pressure**

- On a hot day, air above the Earth becomes hot and expands. This causes a fall of atmospheric pressure in that region.
- During cold chilly nights, air above the Earth cools down. This causes an increase in atmospheric pressure.

**Expected weather changes due to variation of atmospheric pressure**

The changes in atmospheric pressure at a certain place indicate the expected changes in the weather conditions at that place.

**Decrease in atmospheric pressure**

- A gradual and average drop in atmospheric pressure means a low pressure in a neighboring locality.
- Minor but rapid fall in atmosphere indicates a windy and showery condition in the nearby region.
- A decrease in atmospheric pressure accompanied by breeze and rain.
- A sudden fall in atmospheric pressure often followed by a storm, rain and typhoon to occur in few hours time.

**Increase in atmospheric pressure**

- An increasing atmospheric pressure with a decline later on predicts an intense weather conditions.
- A gradual large increase in the atmospheric pressure indicates a long spell of pleasant weather.
- A rapid increase in atmospheric pressure means that it will soon be followed by a decrease in the atmospheric pressure indicating poor weather ahead.

## 7.5 PRESSURE IN LIQUIDS

**Q.No.5 Define pressure in liquids. Derive its mathematical formula.**

**Ans:** Liquids exert pressure. The pressure of a liquid acts in all directions. If we take pressure sensor (a device that measures pressure) inside a liquid, then the pressure of the liquid varies with the depth of sensor.

**Mathematical Derivation**

Consider a surface area A in a liquid at a depth h as shown in figure. The length of the cylinder of liquid over this surface will be h. The force acting on this surface will be the weight w of the liquid above this surface. If ρ is the density of the liquid and m is mass of the liquid above the surface, then

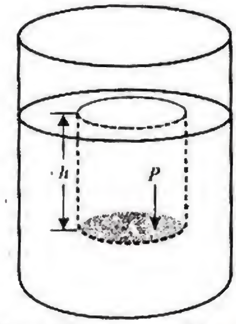


Figure 7.13: Pressure of a liquid at a depth *h*.

Mass of the liquid $= m =$ volume x density

$= m = (A \times h) \times \rho$

Force acting on area A $= F = w = mg$

$= A\,h\,\rho\,g$

As pressure $= P = F/A$

So $= \dfrac{Ah\rho g}{A}$

Therefore, $P = \rho\,g\,h$

The above equation gives the pressure at a depth h in a liquid of density ρ. It show that its pressure in a liquid increases with depth.

## *Pascal's Law*

**Q.No.6 State Pascal's Law. Write down the application of Pascal's law.**

**Ans:** Pressure applied at any point of a liquid enclosed in a container, is transmitted without the loss to all other parts of the liquid.

An external force applied on the surface of a liquid increases the liquid pressure at the surface of the liquid. This increase in liquid pressure is transmitted equally in all direction and to the walls of the container in which it is filled.

**Applications of Pascal's Law (Hydraulic Press)**

Hydraulic press is a machine which works on the principle of Pascal's law. It consists of two cylinders which are fitted with pistons of cross – sectional area a and A. The object is to be compressed is placed over the piston of large cross – sectional area A. the Force is applied on the piston of cross – sectional area a.

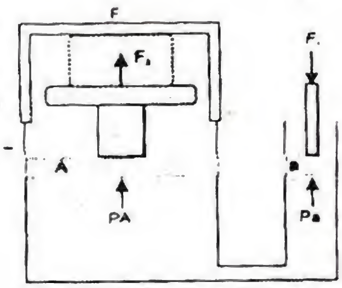


Figure 7.16: A hydraulic press

The pressure P produced by small piston is transmitted through the liquid and acts on the on the large piston and a force $F_2$ acts on A which is much larger than $F_1$.

**Mathematical form**

Pressure on piston of small area a is given by,

$$P = \frac{F_1}{a}$$

By applying Pascal's law, the pressure on the larger piston of area A will be same as on the small piston.

$$P = \frac{F_2}{A}$$

By comparing the above equations, we have

$$\frac{F_1}{a} = \frac{F_2}{A}$$

So,

$$F_2 = F_1 \times \frac{A}{a}$$

Since the ratio A/a is greater than 1, hence the force $F_2$ acts on the larger piston is greater than the force $F_1$ on the smaller piston. Hydraulic systems working in this way are known as force multipliers.

## *Braking System in Vehicles*

**Q.No.7 Explain the braking system of the vehicles.**

**Ans:** The brakes of cars, buses etc. work on the principle of Pascal's law. In such a type of brakes, when brake pedal is pushed, it exerts pressure on the master cylinder, which increases the liquid pressure in the cylinder. The liquid pressure is transmitted equally through the liquid in the metal pipes. Due to the increase pressure of the liquid pressure, the pistons in the cylinder mover outwards pressing the brakes pad with brake drums. The force of friction between friction the brake pads and the brake drum stops the wheels.

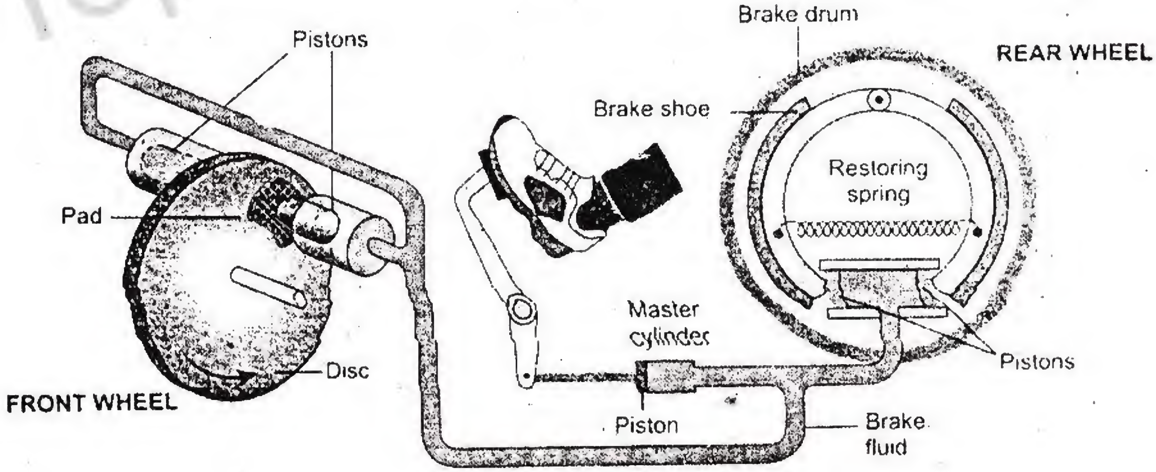


**Figure 7.17:** A hydraulic brake of a car

## 7.6 ARCHIMEDES PRINCIPLE

**Q.No.8 State and explain Archimedes Principle.**

**Ans: Introduction**

More than two thousands years ago, the Greek scientist, Archimedes noticed the upthrust force of the liquid.

**Up thrust force**

There is an upward force which acts on an object kept inside a liquid. As a result an apparent loss of weight is observed in the object. This upward force acting on the object is called the upthrust of the liquid.

**Statement**

When object is totally or partially immersed in a liquid, an upthrust act on it equal to the weight of the liquid it displaces.

**Explanation**

Consider a solid cylinder of cross – sectional area A and height h immersed in a liquid as shown in figure. Let $h_1$ and $h_2$ be the depth of the top and bottom surfaces of the cylinder respectively from the surface of the liquid.

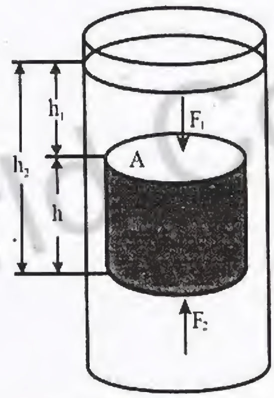


**Figure 7.18:** Upthrust on a body immersed in a liquid is equal to the weight of the liquid displaced

Then $h_2 - h_1 = h$

If $P_1$ and $P_2$ are the liquid pressures at the depth $h_1$ and $h_2$ respectively and $\rho$ is its density, then

$$P_1 = \rho g h_1$$
$$P_2 = \rho g h_2$$

Let the force $F_1$ is exerted at the cylinder top by the liquid due to pressure $P_1$ and the force $F_2$ is exerted at the bottom of the cylinder due to $P_2$.

So $F_1 = \rho g h_1 A$

$F_2 = \rho g h_2 A$

$F_1$ and $F_2$ are acting on the opposite faces of the cylinder. Therefore, the net force F will be $F_2 - F_1$ in the direction of $F_2$. The net force F on the cylinder is called the upthrust of the liquid.

Therefore, $F_2 - F_1 = \rho g h_2 A - \rho g h_1 A$

$= \rho g A (h_2 - h_1)$

OR upthrust of liquid $= \rho g h A$

OR $= \rho g V$

Here Ah is the volume V of the cylinder and equal to the volume of the liquid displaced by the cylinder. Therefore, $\rho g V$ is the weight of the liquid displaced. The above equation shows that an upthrust acts on the body immersed in a liquid and is equal to the weight of liquid displaced, which is Archimedes principle.

### *Density of an Object*

**Q.No.9 How density of an object can be found by Archimedes principle?**

**Ans:** Archimedes principle is also helpful to determine the density of an object. The ratio in the weights of a body with an equal volume of the liquid is the same as in their densities.

Let Density of the object $= D$

Density of the liquid $= \rho$

Weight of the object $= w_1$

Weight of equal volume of liquid $= w = w_1 - w_2$

Here $w_2$ is the weight of solid in liquid. According to Archimedes principle, $w_2$ is less than its actual weight $w_1$ by an amount w.

## 7.7 PRINCIPLE OF FLOATATION

**Q.No.10 Explain the Principle of Floatation.**

**Ans:** An object sinks if its weight is greater than the up thrust force acting on it. An object floats if its weight is equal or less than the up thrust. When an object floats in a fluid, the up thrust acting on it is equal to the weight of the object. In case of floating object, the object may be partially immersed. The up thrust is always equal to the fluid displaced by the object. This is principle of floatation. This states that:

"A floating object displaces a fluid having weight equal to weight of the object."

Archimedes principle is applicable on liquids as well as gases. We find numerous applications of this principle in daily life.

**Ships and Submarines**

A wooden block floats on water. It is because the weight of an equal volume of water is greater than the weight of the block. According to the principle of floatation, a body floats if it displaces water equal to the weight of the body when it is partially or completely immersed in water.

**Ships**

Ships and boats are designed on the same principle of floatation. They carry passengers and goods over water. It would sink in water if its weight including the weight of its passengers and goods becomes greater than the upthrust of water.

**Submarines**

A submarine can travel over as well as under water. It also works on the principle of floatation. It floats over water when the weight of the water equal to its volume is greater than its weight. Under this condition, it is similar to a ship and remains partially above water level. It has a system of tanks which can be filled with and emptied from sea water. When these tanks are filled with sea water, the weight of the submarine increases. As soon as its weight becomes greater than the upthrust, it dives into water and remains under water. To come up on the surface, the tanks are emptied from sea water.

## 7.9 HOOKE'S LAW

**Q.No.11 State and explain the Hooke's Law.**

**Ans:** The strain produced in a body by the stress applied to it is directly proportional to the stress within the elastic limit of the body.

**Mathematical Formula**

Stress $\alpha$ strain

Stress = constant x strain

Or $\frac{\text{Stress}}{\text{Strain}}$ = constant

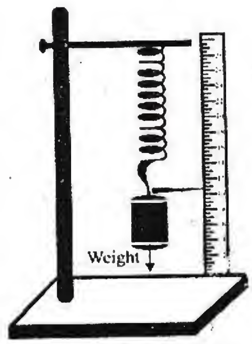

**Figure7.23:** Extension in the spring depends upon the load

Hooke's law is applicable to all kinds of deformation and all types of matter i.e. solids, liquids or gases within certain limit.

**Elastic Limit**

It is a limit with which a body recovers to original length, volume or shape after deforming force is removed. This limit is called the elastic limit.

When a stress crosses this limit, called the elastic limit, a body is permanently deformed and is unable to restore its original state after the stress is removed.

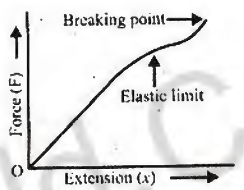

**Figure 7.24:** Graph between force and extension

### *Young's Modulus*

**Q.No.12 Define Young's Modulus and derive its mathematical formula.**

**Ans:** The ration of stress and strain is a constant within the elastic limit, this constant is called the Young's Modulus.

**Mathematical Form**

Consider a long bar of length Lo and cross – sectional area A. Let an external force F equal to weight stretches it such that the stretched length becomes L.

Mathematically,

Young's modulus = Y = Stress/Tensile strain

Let $\Delta L$ be the change in length of the rod, then

$$\Delta L = L - L_o$$

Since Stress = $\frac{\text{Force}}{\text{Area}}$ = F/A

And Tensile Strain = $\frac{L - L_o}{L_o}$ = $\Delta L/L_o$

As Young's modulus = Y = Stress/Tensile strain

So $= \frac{F}{A} \times \frac{L_o}{L}$

Therefore, $= \frac{F \times L_o}{A \times L}$

**Unit**

SI unit of Young's Modulus is Newton per square meter ($N\ m^{-2}$)

## TEXTBOOK EXERCISE

## QUESTIONS

**7.1 Encircle the correct answer from the given choices.**

**i. In which of the following state, molecules do not leave their position:**

**a) Solid** b) liquid c) gas d) plasma

**ii. Which of the substances is the lightest one?**

a) Copper b) mercury **c) aluminum** d) lead

**iii. SI unit of pressure is Pascal, which is equal to?**

a) $10^{-4}$ $Nm^{-2}$ **b) 1 $Nm^{-2}$** c) $10^{2}$ $Nm^{-2}$ d) $10^{3}$ $Nm^{-2}$

**iv. What should be the approximate length of a glass tube to construct a water barometer?**

a) 0.5 m b) 1 m c) 2.5 m **d) 11 m**

**v. According to Archimedes, upthrust is equal to:**

a) Weight of displace body b) volume of displaced body

c) mass of displaced liquid **d) none of these**

**vi. The density of a substance can be found with the help of:**

a) Pascal's law b) Hooke's law

**c) Archimedes principle** d) principle of floatation

**vii. According to Hooke's law:**

a) Stress x strain = constant **b) stress/strain = constant**

c) strain/stress = constant d) stress = strain

**7.2 How kinetic molecular model is helpful in differentiating various states of matter?**

**Ans:** See Q. 1 Long Question

**7.3 Does there exist a fourth state of matter? What is that?**

**Ans:** Yes, there exists a fourth state of matter called Plasma.

At very high temperature, atoms lose their electrons and become positive ions. This ionic state of matter consisting of ions and electrons is called plasma.

**7.4 What is meant by a density? What is its SI unit?**

**Ans:** Density of a substance is defined as its mass per unit volume.

Density = mass of a substance/volume of that substance

**Unit**

SI unit of density is kilogram per cubic meter ($kg\ m^{-3}$).

**7.5 Can we use a hydrometer to measure the density of milk?**

**Ans:** Hydrometer is a device which is used to measure the density of liquids. So it can be used to measure the density of milk.

**7.6 Define the term pressure.**

**Ans:** The force acting normally per unit area on the surface of a body is called pressure.

Thus P = Force/Area

Or P = F/A

**Quantity**

Pressure is a scalar quantity.

**Unit**

In SI units, the unit of pressure is $N\ m^{-2}$ also called Pascal (Pa). Thus, $1N\ m^{-2} = 1Pa$

**7.7 Show that atmosphere exerts pressure.**

**Ans:** The atmosphere of Earth consists of gases, vapors and dust particles. All these are material particles. Due to the force of gravity these particles they exert pressure. So any object inside the atmosphere experience pressure which is called the atmospheric pressure.

**7.8 It is easy to remove air from a balloon but it is very difficult to remove air from a glass bottle. Why?**

**Ans:** Because the atmospheric pressure acts more easily on balloon as compared to glass bottle, so emptying air is easier from balloon than glass bottle.

**7.9 What is barometer?**

**Ans:** The instrument used to measure atmospheric pressure is called barometer. One of the simple barometers is mercury barometer. It consists of a glass tube 1m long closed at one end.

**7.10 Why water is not suitable to be used in a barometer?**

**Ans:** Mercury is 13.6 times denser than water. Atmospheric pressure can hold vertical column of water is about 13.6 times the height of mercury column at a place. Thus, at sea level, vertical height of water column would be 0.76 m x 13.6 = 10.34 m. Thus, a glass tube more than 10 m long is required to make a water barometer.

**7.11 What makes a sucker pressed on a smooth wall sticks to it?**

**Ans:** When a sucker is pressed on a smooth surface, the air pressure below it becomes very small (due to the displaced air) as compared to the air pressure above it. Therefore, it sticks with the smooth surface.

**7.12 Why does the atmospheric pressure vary with height?**

**Ans:** As we go high in the atmosphere, the density of the air becomes low. Due to this reason, atmospheric pressure decreases as we go high.

**7.13 What does it mean when the atmospheric pressure at place fall suddenly?**

**Ans:** A sudden fall in atmospheric pressure often followed by a storm, rain and typhoon to occur in few hours time.

**7.14 What changes are expected in weather if the barometer reading shows a sudden increase?**

**Ans:** A sudden increase in atmospheric pressure means that it will soon followed by a decrease in the atmospheric pressure indicating poor weather ahead.

**7.15 State Pascal's law.**

**Ans:** Pressure applied at any point of a liquid enclosed in a container, is transmitted without the loss to all other parts of the liquid.

**7.16 Explain the working of hydraulic press.**

**Ans:** See Q.6 Long Question

**7.17 What is meant by elasticity?**

**Ans:** The property of matter by virtue of which matter resists any force which tries to change its length, shape or volume is called elasticity.

**7.18 State Archimedes principle?**

**Ans:** When object is totally or partially immersed in a liquid, an upthrust act on it equal to the weight of the liquid it displaces.

**7.19 What is up thrust? Explain the principle of floatation.**

**Ans:** See Q. 8 & 10 Long Questions

**7.20 Explain how a submarine moves up the water surface and down into water.**

**Ans:** See Q. 10 Long Question

**7.21 Why does a piece of stone sink in water but a ship with a huge weights float?**

**Ans:** The upthrust force on stone is much smaller than its weight because weight of the water displaced under stone is very small. While the ships are designed in such a way weight of the water displaced by them is greater than their weight. So upthrust force in case of ships is greater than their weights. So ships float on the surface of water.

**7.22 What is Hooke's law? What is meant by elastic limit?**

**Ans:** **Hooke's Law**

The strain produced in a body by the stress applied to it is directly proportional to the stress within the elastic limit of the body.

**Elastic Limit**

It is a limit within which a body coves recovers its original length, volume or shape after deforming force is removed is called elastic limit.

When a body crosses this limit, it is permanently deformed and is unable to restore its original state after the stress is removed.

**7.23 Take a rubber band. Construct a balance of you own using a rubber band. Check its accuracy by weighing various objects.**

**Ans:** Take a rubber band hang it with a hook. Then pointer is attached at the lower end of it with scale in front of pointer. Different known weights are suspended one by one at the lower end of the rubber band. Mark the pointer positions for each known weight. It is called calibration of scale for weight measurements. This makes a balance for weight measurement.

# PROBLEMS

**7.1 A wooden block measuring 40 cm x 10cm x 5 cm has a mass of 850 g. find the density of the wood.**

**Given Data**

Volume of wooden block = v = 40 cm x 10 cm x 5 cm = 2000 $cm^3$ = 2 x $10^{-3}$ $m^3$

Mass of wooden block = m = 850 g = 0.85 kg

**Required**

Density of wooden block = d = ?

**Solution**

As we know that

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

By putting the values, we have

$$\text{Density} = \frac{0.85}{2\times10^{-3}}$$

$$\text{Density} = 0.425 \times 10^{3}\ kg\ m^{-3}$$

OR $$\text{Density} = 425\ kg\ m^{-3}$$

**Result**

**Density of wooden block = d = 425 $kgm^{-3}$**

**7.2 How much would be the volume of the ice formed by freezing 1 liter of water?**

**Given Data**

Volume of water = $V_1$ = 1 litre

**Required**

Volume of ice on freezing = $V_2$ = ?

**Solution**

As we know that

$$\frac{\text{Volume of ice}}{\text{volume of water}} = \frac{\text{density of water}}{\text{density of ice}}$$

So $$\text{volume of ice} = \left(\frac{\text{density of water}}{\text{density of ice}}\right) \times \text{volume of water}$$

Putting values, we have

Volume of ice = (1000/920) x 1

Volume of ice = 1.09 litres

**Result**

**Volume of ice on freezing = $V_2$ = 1.09 litres**

**7.3 (i) Calculate the volume of the following objects.**

(i) An iron sphere of mass 5 kg, the density of iron is 8200 $kgm^{-3}$.

(ii) 200 g of lead shot having density 11300 $kgm^{-3}$.

(iii)A gold bar of mass 0.2 kg. the density of gold is 19300 $kgm^{-3}$.

(i) **An iron sphere of mass 5 kg, the density of iron is 8200 $kgm^{-3}$.**

**Given Data**

Mass of iron sphere = m = 5 kg

Density of iron = d = 8200 $kgm^{-3}$

**Required**

Volume of iron sphere = V = ?

**Solution**

As we know that

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$\text{Volume} = \frac{\text{Mass}}{\text{Density}}$$

By putting the values, we have

$$\text{Volume} = \frac{5}{8200}$$

Volume = 0.00069 $m^3$

OR Volume = $6.9 \times 10^{-4}\ m^3$

**Result**

**Volume of iron sphere = V = $6.9 \times 10^{-4}\ m^3$**

**7.3 (ii) 200 g of lead shot having density 11300 $kgm^{-3}$.**

**Given Data**

Mass of lead shot = m = 200 g = 0.2 kg

Density of lead = d = 11300 $kgm^{-3}$

**Required**

Volume of lead shot = v = ?

**Solution**

As we know that

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$\text{Volume} = \frac{\text{Mass}}{\text{Density}}$$

By putting the values, we have

$$\text{Volume} = \frac{0.2}{11300}$$

Volume = 0.000017699 $m^3$

OR Volume = $1.77 \times 10^{-5}\ m^3$

**Result**

**Volume of lead shot = v = $1.77 \times 10^{-5}\ m^3$**

**7.3 (iii) A gold bar of mass 0.2 kg. the density of gold is 19300 $kgm^{-3}$.**

**Given Data**

Mass of gold bar = m = 0.2 kg

Density of gold = d = 19300 $kgm^{-3}$

**Required**

Volume of gold bar = v = ?

**Solution**

As we know that

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$\text{Volume} = \frac{\text{Mass}}{\text{Density}}$$

By putting the values, we have

$$\text{Volume} = \frac{0.2}{19300}$$

$$\text{Volume} = 0.00001036\ m^3$$

OR $\text{Volume} = 1.04 \times 10^{-5}\ m^3$

**Result**

**Volume of gold bar = v = 1.04 x $10^{-5}$ $m^3$**

**7.4 The density of air is 1.3 $kgm^{-3}$. Find the mass of air in room measuring 8 m x 5 m x 4 m.**

**Given Data**

Density of air = d = 1.3 $kgm^{-3}$

Volume of air = v = 8 m x 5 m x 4 m = 160 $m^3$

**Required**

Mass of air = m = ?

**Solution**

As we know that

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

So Mass = density x volume

By putting the values, we have

Mass = 1.3 x 160

Mass = 208 kg

**Result**

**Mass of air = m = 208 kg**

**7.5 A student passes her palm by her thumb with a force of 75 N. how much would be the pressure under her thumb having contact area 1.5 $cm^2$?**

**Given Data**

Force exerted by student = F = 75 N

Contact area = A = 1.5 $cm^2$ = 1.5 x $10^{-4}$ $m^2$

**Required**

Pressure under the thumb = P = ?

**Solution**

As we know that

$$P = \frac{F}{A}$$

By putting the values, we have

$$P = \frac{75}{1.5 \times 10^{-4}}$$

$P = 50 \times 10^4\ Nm^{-2}$

$P = 5 \times 10^5\ Nm^{-2}$

**Result**

**Pressure under the thumb = P = $5 \times 10^5\ Nm^{-2}$**

**7.6 The head of the pin is a square of side 10 mm. find the pressure on it due to a force of 20 N.**

**Given Data**

Force applied = F = 20 N

Side of head of pin = L = 10 mm = $10 \times 10^{-3}$ m

Area of head of pin = A = L x L = $10 \times 10^{-3}$ m x $10 \times 10^{-3}$ m

= $100 \times 10^{-6}\ m^2 = 1 \times 10^{-4}\ m^2$

**Required**

Pressure exerted by head of pin = P = ?

**Solution**

As we know that

$$P = \frac{F}{A}$$

By putting the values, we have

$$P = \frac{20}{1 \times 10^{-4}}$$

$P = 20 \times 10^4\ Nm^{-2}$

$P = 2 \times 10^5\ Nm^{-2}$

**Result**

**Pressure exerted by head of pin = P = $2 \times 10^5\ Nm^{-2}$**

**7.7 A uniform rectangular block of wood 20 cm x 7.5 cm x 7.5 cm and of mass 1000 g stands on a horizontal surface with its longest edge vertical. Find**

**(i)** The pressure exerted by the block on the surface

**(ii)** Density of the wood

**Given Data**

Mass of wooden block = m = 1000 g = 1 kg

Volume of wooden block = V = 20 cm x 7.5 cm x 7.5 cm

= $0.001125\ m^3$ or $1.125 \times 10^{-3}$

Area of wooden block = A = 7.5 cm x 7.5 cm

= $0.005625\ m^2$ or $5.625 \times 10^{-3}\ m^2$

**Required**

(i) The pressure exerted by the block on the surface = P = ?

(ii) Density of wood = d =?

**Solution**

As we know that

$$V = L \times W \times H$$

By putting the values, we have

$$V = 20 \text{ cm} \times 7.5 \text{ cm} \times 7.5 \text{ cm} = 1125 \text{ cm}^3 = 0.001125 \text{ m}^3$$

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

By putting the values, we have

$$\text{Density} = \frac{1}{0.001125}$$

$$\text{Density} = 888.89 \text{ kgm}^{-3} = 889 \text{ kgm}^{-3}$$

As we know that

$$P = \frac{F}{A}$$

By putting the values, we have

$$P = \frac{10}{0.005625}$$

$$P = 1778 \text{ Nm}^{-2}$$

**Result**

**(i) The pressure exerted by the block on the surface = P = 1778 $Nm^{-2}$**

**(ii) Density of wood = d = 889 $kgm^{-3}$**

**7.8 A cube of glass of 5 cm side and mass 306 g, has a cavity inside it. If the density of the glass is 2.55 $gcm^{-3}$. Find the volume of the cavity.**

**Given Data**

Length of side of glass cube = L = 5 cm

Volume of glass cube = v = $L^3 = (5 \text{ cm})^3 = 125 \text{ cm}^3$

$= 125 \times 10^{-6} \text{ m}^3 = 1.25 \times 10^{-4} \text{ m}^3$

Mass of cube = m = 306 g = 0.306 kg = $3.06 \times 10^{-1}$ kg

Density of glass = d = 2.25 $gcm^{-3}$ = $2.55 \times 10^{3} \text{kg m}^{-3}$

**Required**

Volume of cavity inside the glass cube = V = ?

**Solution**

Volume without cavity = $1.25 \times 10^{-4} \text{ m}^3$

Volume with cavity = mass/density

$= (3.06 \times 10^{-1})/(2.55 \times 10^{3})$

$= 1.20 \times 10^{-4} \text{ m}^3$

Volume of cavity = volume without cavity – volume with cavity

$= 1.25 \times 10^{-4}\ m^3 - 1.20 \times 10^{-4}\ m^3$

$= 0.05 \times 10^{-4}\ m^3$

$= 5 \times 10^{-6}\ m^3$ or $5\ cm^3$

**Result**

**Volume of cavity inside the glass cube = v = 5 cm$^3$**

**7.9 An object has weight 18 N in air. Its weight is found to be 11.4 N when immersed in water. Calculate its density. Can you guess the material of the object?**

**Given Data**

Weight of object in air = $w_1$ = 18 N

Weight of object in water = $w_2$ = 11.4 N

Density of water = $\rho_w$ = 1000 kgm$^{-3}$

Gravitational acceleration = g = 10 ms$^{-2}$

Weight of equal volume of water = $w = w_1 - w_2$ = 18 N – 11.4 N = 6.6 N

**Required**

Density of material = $D_m$ = ?

Name of material = ?

**Solution**

As we know that

$$\frac{D}{\rho} = \frac{w_1}{w}$$

By putting the value, we have

$$\frac{D}{1000} = \frac{18}{6.6}$$

$$D = \frac{18000}{6.6}$$

$$D = 2727\ Kgm^{-3}$$

**Result**

**Density of material = $D_m$ = 2727 Kgm$^{-3}$**

As we know that density of aluminum is approximately equal to the density found in the numerical. So, the material is aluminum.

**7.10 A solid block of wood of density 0.6 gcm$^{-3}$ weighs 3.06 N in air. Determine,**

**(i)** Volume of the block

**(ii)** The volume of block immersed when placed freely in liquid of density 0.9 gcm-3.

**Given Data**

Density of wooden block = d = 0.6 gcm$^{-3}$

Weight of the wooden block = w = 3.06 N

Density of liquid = $d_l$ = 0.9 gcm$^{-3}$

**Required**

Volume of the wooden block = $V_1$ = ?

Volume of block when immersed in liquid = $V_2$ = ?

**Solution**

As we know that

$$\text{Volume} = \text{mass/ density}$$

$$V_1 = 0.306/(0.6 \times 10^3) \qquad = 0.51 \times 10^{-3}\ m^3 \text{ or } 510 cm^3$$

As we also know that

Upward thrust = weight of the liquid displaced

Weight= 10 x volume x density

$$3.06 = 10 \times \text{volume} \times 0.9 \times 10^3$$

$$\text{Volume} = 3.06/(9 \times 10^3)$$

$$V_2 = 0.00034\ m^3 \text{ or } 34\ cm^3$$

**Result**

**Volume of the wooden block = $V_1$ = 510 $cm^3$**

**Volume of block when immersed in liquid = $V_2$ = 34 $cm^3$**

**7.11 The diameter of the piston of hydraulic press is 30 cm. How much force is required a car weighing 20000 N on its piston, if the diameter of the piston of the pump is 3 cm.**

**Given Data**

Diameter of the piston of hydraulic press = D = 30 cm = 0.3 m

Diameter of the piston of pump = d = 3 cm = 0.03 m

Weight of the car lifted by hydraulic press = w = $F_2$ = 20000 N

**Required**

Force applied on piston of pump = $F_1$ = ?

**Solution**

As we know that

$$A = \frac{\pi D^2}{4}$$

**(i) Larger piston**

By putting the values, we have

$$A = \frac{3.14 \times (3 \times 10^{-1})^2}{4}$$

$$A = \frac{3.14 \times 9 \times 10^{-2}}{4}$$

$$A = \frac{28.26 \times 10^{-2}}{4}$$

$$A = 7.065 \times 10^{-2}\ m^2$$

**(ii) Smaller piston**

By putting the value, we have

$$a = \frac{3.14 \times (3 \times 10^{-2})^2}{4}$$

$$a = \frac{3.14 \times 9 \times 10^{-4}}{4}$$

$$a = \frac{28.26 \times 10^{-4}}{4}$$

$$a = 7.065 \times 10^{-4}\ m^2$$

From Pascal's law, we have

$$\frac{F_1}{a} = \frac{F_2}{A}$$

By putting the values, we have

$$\frac{F_1}{7.065 \times 10^{-4}} = \frac{20000}{7.065 \times 10^{-2}}$$

$$F_1 = \frac{20000 \times 7.065 \times 10^{-4}}{7.065 \times 10^{-2}}$$

$$F_1 = \frac{20000}{100}$$

$$F_1 = 200\ N$$

**Result**

**Force applied on piston of pump = $F_1$ = 200 N**

**7.12 A steel wire of cross-sectional area $2 \times 10^{-5}\ m^2$ is stretched through 2 mm by a force of 4000 N. Find the young's modulus of the wire. The length of the wire is 2m.**

**Given Data**

Length of the wire = $L_o$ = 2 m
Area of steel wire = A = $2 \times 10^{-5}\ m^2$
Increase in length of wire = $\Delta L$ = 2 mm = $2 \times 10^{-3}$ m
Force applied = F = 4000 N

**Required**

Young's modulus of wire = Y = ?

**Solution**

As we know that

$$Y = \frac{F \times L}{A \times \Delta L}$$

By putting the values, we have

$$Y = \frac{4000 \times 2}{2 \times 10^{-5} \times 2 \times 10^{-3}}$$

$$Y = \frac{2000}{10^{-5} \times 10^{-3}}$$

$$Y = 2000 \times 10^{8}\ Nm^{-2} = 2 \times 10^{3} \times 10^{8}\ Nm^{-2}$$

$$Y = 2 \times 10^{11}\ Nm^{-2}$$

**Result**

**Young's modulus of wire = Y = $2 \times 10^{11}\ Nm^{-2}$**